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XIV. *An Account of the Means employed to obtain an overflowing Well. In a Letter to the Right Honourable Sir Joseph Banks, Bart. K. B. P. R. S. from Mr. Benjamin Vulliamy.*

Read May 25, 1797.

SIR,

PERMIT me, in compliance with your request, to give you a short account of the well at Norland House, belonging to Mr. L. VULLIAMY; a work of great labour and expence, executed entirely under my direction, and finished in November, 1794.

Before I began the work, I considered that it would be of infinite advantage, should a spring be found strong enough to rise over the surface of the well; and though I thought it very improbable, yet I resolved to take from the beginning the same precautions in doing the work, as if I had been assured that such a spring would be found. But although this very laborious undertaking has succeeded beyond my expectation, yet from the knowledge I have acquired in the progress of the work, I am of opinion that it will very seldom happen that the water will rise so high; nor will people, I believe, in general, be so indefatigable as I have been in overcoming the various difficulties that did and ever will occur, in bringing such a work to perfection.

In beginning to sink this well, which has a diameter of four feet, the land springs were stopped out in the usual manner, and the well was sunk and steined to the bottom. When the

workmen had got to the depth of 236 feet, the water was judged not to be very far off, and it was not thought safe to sink any deeper. A double thickness of steining was made about 6 feet from the bottom upwards, and a borer of $5\frac{1}{4}$ inches diameter was made use of. A copper pipe of the same diameter with the borer was driven down the bore-hole to the depth of 24 feet, at which depth the borer pierced through the rock into the water; and by the manner of its going through, it must probably have broken into a stratum containing water and sand. At the time the borer burst through, the top of the copper pipe was about 3 feet above the bottom of the well: a mixture of sand and water instantly rushed in through the aperture of the pipe. This happened about two o'clock in the afternoon, and by twenty minutes past three o'clock the water of the well stood within 17 feet of the surface. The water rose the first $1\frac{2}{4}$ feet in eleven minutes, and the remaining 119 feet in one hour and nine minutes. The next day several buckets of water were drawn out, so as to lower the water 4 or 5 feet; and in a short time the water again rose within 17 feet of the surface. A sound-line was then let down into the well in order to try its depth. To our great surprise the well was not found by 96 feet so deep as it had been measured before the water was in it; and the lead brought up a sufficient quantity of sand to explain the reason of this difference, by shewing that the water had brought along with it 96 feet of sand into the well. Whether the copper pipe remained full of sand or not, is not easy to be determined; but I should rather be inclined to think it did not.

After the well had continued in the same state several days, the water was drawn out so as to lower it 8 or 10 feet; and

it did not rise again by about a foot so high as it had risen before. At some days interval water was again drawn out, so as to lower the water as before; which at each time of drawing rose less and less, until after some considerable time it would rise no more; and the water being then all drawn out, the sand remained perfectly dry and hard. I now began to think the water lost; and, consequently, that all the labour and expence of sinking this well, which by this time were pretty considerable, had been in vain. There remained no alternative but to endeavour to recover it by getting out the sand, or all that had been done would be useless; and although it became a more difficult task than sinking a new well might have been, yet I determined to undertake it, because I knew another well might also be liable to be filled with sand in the same manner that this was. The operation of digging was again necessarily resorted to, and the sand was drawn up in buckets until about 60 feet of it were drawn out, and, consequently, there remained only 36 feet of sand in the well : that being too light to keep the water down, in an instant it forced again into the well with the same violence it had done before; and the man who was at the bottom getting out the sand, was drawn up almost suffocated, having been covered all over by a mixture of sand and water. In a short time the water rose again within 17 feet of the surface, and then ceased to rise, as before. When the water had ceased rising, the sounding-line was again let down, and the well was found to contain full as much sand as it did the first time of the water's coming into it.

Any further attempt towards recovering the water appeared now in vain; and most people would, I believe, have abandoned the undertaking. I again considered that the labour and the

expence would be all lost by so doing; and I determined without delay to set about drawing the sand out through the water, by means of an iron box made for that purpose, without giving it time to harden as before. The labour attending on this operation was very great, as it was necessary continually to draw out the water, for the purpose of keeping it constantly rising through the sand, and thereby to prevent the sand from hardening. What rendered this operation the more discouraging was, that frequently after having drawn out 6 or 7 feet of sand in the course of the day, upon sounding the next morning the sand was found lowered only 1 foot in the well, so that more sand must have come in again. This, however, did not prevent me from proceeding in the same manner during several days, though with little or no appearance of any advantage arising from the great exertions we were making. After persevering, however, for some considerable time, we perceived that the water rose a little nearer to the surface, and I began to entertain some hopes that it might perhaps rise high enough to come above the level of the ground; but when the water had risen a few feet higher in the well, some difficulties occurred, occasioned by accidental circumstances, which very much delayed the progress of the work; and it remained for a considerable time very uncertain whether the water would run over the top of the well or not.

These difficulties being at length surmounted, we continued during several days the process before mentioned, of drawing out the sand and water alternately; and I had the satisfaction of seeing the water rise higher and higher, until at last it ran over the top of the well, into a temporary channel that conveyed it into the road. I then flattered myself that every difficulty

was overcome ; but a few days afterwards I discovered that the upper part of the well had not been properly constructed, and it became necessary to take down about 10 feet of brick-work. The water, which was now a continued stream, rendered this extremely difficult to execute. I began by constructing a wooden cylinder 12 feet long, which was let down into the well, and suspended to a strong wooden stage above, upon which I had fixed two very large pumps, of sufficient power to take off all the water that the spring could furnish, at 11 feet below the surface. The stage and cylinder were so contrived as to prevent the possibility of any thing falling into the well; and I contrived a gage, by which the men upon the stage could always ascertain to the greatest exactness the height of the water within the cylinder. This precaution was essentially necessary, in order to keep the water a foot below the work which was doing on the outside of the cylinder, to prevent the new work from being wetted too soon. After every thing was prepared, we were employed eight days in taking down 10 feet of the wall of the well, remedying the defects, and building it up again ; during which time ten men were employed, five relieving the other five, and the two pumps were kept constantly at work during one hundred and ninety-two hours. By the assistance of the gage, the water was never suffered to rise upon the new work until it was made fit to receive it. When the cylinder was taken out, the water again ran over into the temporary channel that conveyed it into the road.

The top of the well was afterwards raised 18 inches, and constructed in such a manner as to be able to convey the water

five different ways at pleasure, with the power of being able to set any of these pipes dry at will, in order to repair them whenever occasion should require. The water being now entirely at command, I again resolved upon taking out more sand, in order to try what additional quantity of water could be obtained thereby. I cannot exactly ascertain the quantity of sand taken out, but the increase of water obtained was very great; as instead of the well discharging thirty gallons in a minute, the water was now increased to forty-six gallons in the same time.

If you think, Sir, that the above account of an overflowing well, the joint production of nature and art, is deserving your attention, I feel myself much gratified in the pleasure I have in giving you this description of it; and have the honour of being, with the greatest regard,

SIR, &c.

B. VULLIAMY.

EXPLANATION OF THE PLATE. (Tab. VII.)

Fig. 1.

- a* Top of the well, with the water running over.
- b b* Ground line.
- c* Sand lying in the well.
- d* Copper pipe.
- ffffff* Steining of the well.
- g g* Double steining six feet from the bottom upwards.
- b* Stratum which the end of the copper pipe was driven into.

Fig. 2. and 3.

Iron box for drawing sand out of the well, weighing about 60lbs. one foot square, and two feet nine inches long.

a Handle of the box.

b A flap or door, which opens inwards by a joint at *c*. There is another door like this on the other side.

c The joint.

d The centre or pin of the joint.